CS5463: Using the Epsilon Register & AFC Function in Reactive Power and Line Frequency Measurements

1. INTRODUCTION

In the CS5463, average reactive power (Qavg) is generated by averaging the voltage multiplied by the current with a 90° phase shift between them. The 90° phase shift is realized by a digital filter. This filter will give exactly -90° phase shift across all frequencies, and utilizes Epsilon (ε) to achieve unity gain at the line frequency. To attain accurate Qavg result over line-frequency variation, the Epsilon register has to be updated in accord with the line frequency.

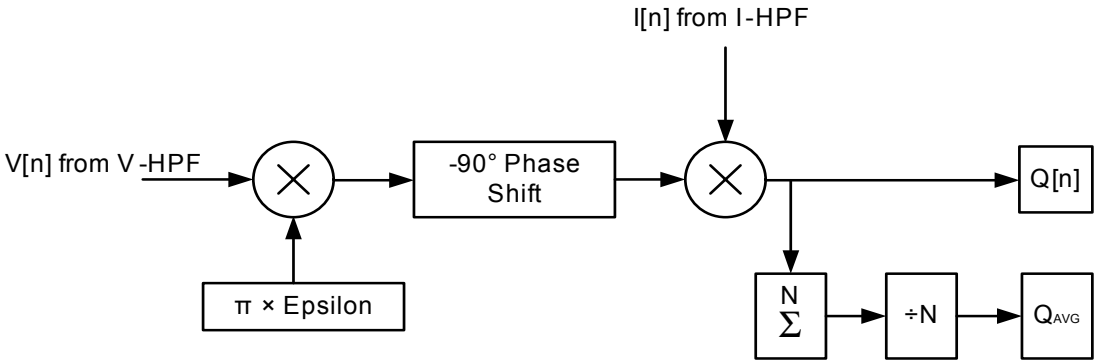

Figure 1. Average Reactive Power Data Flow

2. THE RELATIONSHIP BETWEEN THE EPSILON REGISTER AND LINE FREQUENCY

The value in the Epsilon register is the ratio of the line frequency to the output word rate (OWR).

Epsilon = Line Frequency / OWR

By default, Epsilon is set as 0x1999F or 0.0125 decimal for 50 Hz line frequency and 4000 Hz OWR. If the CS5463 is used in different line and OWR frequencies, Epsilon must be reconfigured accordingly. For example, if the line frequency is 60 Hz and OWR is 4000 Hz, Epsilon should be reconfigured as 60 / 4000 = 0.015.

3. AFC - AUTOMATIC FREQUENCY CALCULATION

Epsilon can be calculated automatically by the CS5463 by setting the AFC bit in the Operational Mode (Mode) register. The Frequency Update bit (FUP) in the Status register is set every time the Epsilon register has been automatically updated.

To achieve 0.1% resolution, the Epsilon update period is fixed at 1000 zero-crossings or 10 seconds for 50 Hz line frequency. In other words, the delay between the line frequency change and the correct Epsilon output will be around 20 seconds (worst case) for a 50 Hz system.

In power meter applications, there are strict requirements for the limit of reactive power error due to line frequency variation. The AFC function can keep the Epsilon register automatically updated with line frequency changes to ensure accurate reactive power calculations.

If the measurement delay is not important to the application, the AFC function can be used to measure the line frequency as well.

Line Frequency = Epsilon × OWR

4. PRECAUTIONS WHEN USING THE AFC IN THE CS5463 REVISION D

In revision D of the CS5463, the HPF settling time has been increased to 3000 samples or 3000/OWR seconds (see the CS5463 Technical Bulletin). However, this settling time was not taken into account by the automatic Epsilon calculation. This may make the 1st Epsilon and Qavg results inaccurate if the AFC is enabled before HPF has settled. See Figure 2.

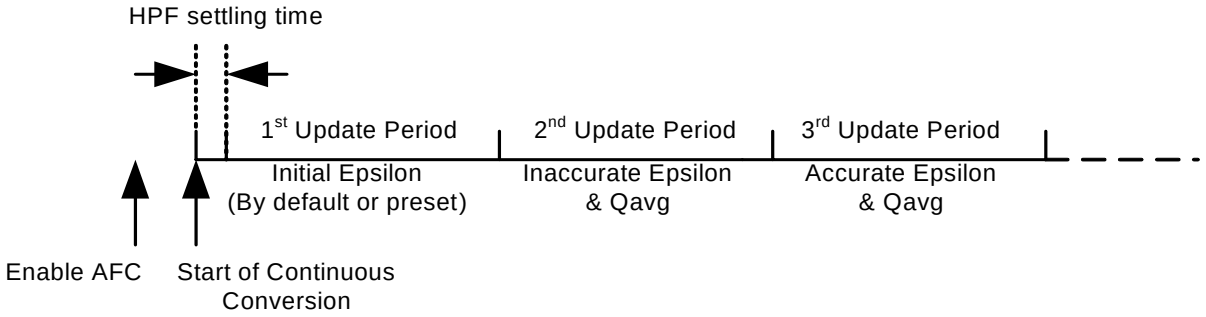

Figure 2. HPF Settling Time – AFC Enabled Before Start of Conversion

To solve this problem, the AFC should be enabled at least 3000/OWR seconds after the continuous conversion has started. See Figure 3.

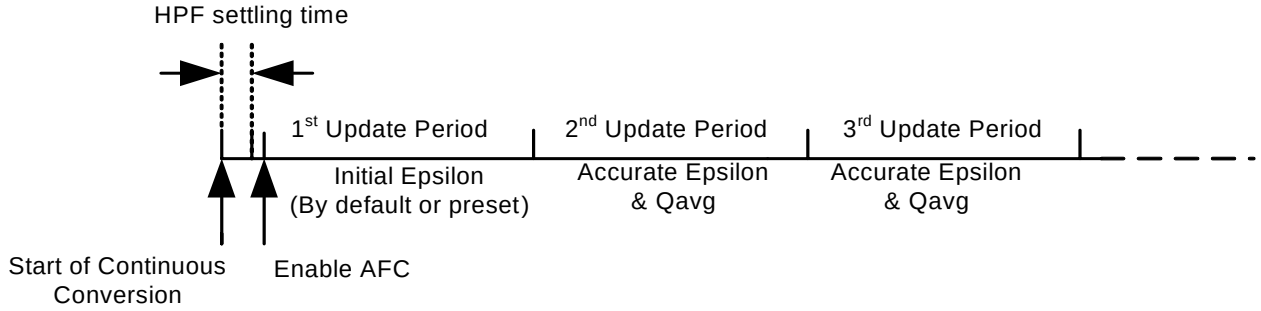

Figure 3. HPF Settling Time – AFC Enabled After HPF Has Settled

5. CONCLUSION

The Epsilon register plays an important role in the CS5463 reactive power and line frequency calculations. To avoid inaccurate measurements, the Epsilon register should be preset based on the line frequency, and the AFC should be enabled with some delay after the start of continuous conversions to allow the CS5463 to automatically track any line frequency variation.

Contacting Cirrus Logic Support

For all product questions and inquiries contact a Cirrus Logic Sales Representative.
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